

Electromagnetic-Hydraulic-Pneumatic Hybrid Artillery Projection System Featuring Novel Hydraulic Fluid Compression Mechanism and Pressure Recycling Feature

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Introduction

Just as there are limits upon the ability to manufacture the metallurgical components of artillery shells, there are limits upon the ability to manufacture the high-explosive propellant needed to make artillery shells. To safely manufacture these propellants, exceptional precautions must be taken. The storage of such propellants is expensive and dangerous in its own right. Propellants and the metallic component of an artillery shell are never manufactured in the same facility, necessitating integration of these components, which implies additional transportation costs. Although there is little avoiding the need for a high-explosive warhead, the use of explosives to propel an artillery shell is something which may be rendered obsolete. Non-heat-generating methods of propulsion would reduce barrel wear and mitigate hearing damage to operators of artillery units. Range limitations of conventional artillery may be overcome by utilizing an alternative method of propulsion.

Abstract

An electromagnetic-hydraulic-pneumatic hybrid system for the propulsion of an artillery shell has the potential to not only match the performance of high-explosive solid propellants, but to exceed it. Whereas high-explosive propellants are limited in terms of the space they may occupy (the size of the shell sets the upper limit upon amount of propellant used,) a hydraulic system can be made to take advantage of greater volumes of fluid and can be re-used, whereas solid propellants are one-time-use only.

This author proposes the construction of a system in which a pneumatic pressure wave is injected into a barrel just ahead of a hydraulic pressure wave. When the hydraulic pressure wave catches up with the pneumatic wave, the water is atomized and rendered as a gas-like air-water mixture. This air-water mixture is essential for preventing the propagation of reflected density waves in the inverse direction back down the primary barrel. In essence, it provides a kind of cushion which ensures that as much of the kinetic energy of the hydraulic wave as possible is converted into the kinetic energy of the munition.

By the time the hydraulic wave reaches the mid-point of the barrel, it continues to retain significant energy. The majority of this energy may be recycled using a system of shutters which form part of a fluid redirection system.

The primary barrel would be surrounded with a fluid backflow sheath. When a projectile clears the mid-point of the barrel where the shutter is located, the

shutter slams shut, containing the majority of the water used to propel the projectile. The shutter's shape would be optimized to redirect the fluid into the backflow sheath and to mitigate the tendency toward reflection into the primary barrel.

The backflow sheath would direct the fluid back into the pressurization tank where its substantial velocity would allow for the fluid to be re-contained at a pressure level of about 2/3rds of the full pressure called for to fire the next round. Another shutter contains this fluid by slamming shut at the appropriate time.

Another mechanism is needed to make such a system practical, that being a mechanism which greatly enhances the upper boundaries of the level of compression possible with a traditional compressor.

While initial pressurization may be achieved using a traditional diesel engine linked to pistons and an injection valve, compression beyond that possible with most engines is required in order to project artillery over the requisite distance or to achieve the goal of matching or exceeding those distances possible with traditional artillery.

Sliding Watertight Barrier, Electromagnetic Attraction of Plate

Once initial pressurization is achieved, the level of pressurization of a hydraulic fluid may be rapidly multiplied by the use of a free-floating plate which is as near as possible to being watertight whilst retaining the ability to freely slide along a cylindrical containment vessel.

Electrical arcing is generated in the gap area needed to allow the plate to freely slide. The arcing renders any water circumventing the plate as a plasma and prevents the leakage of the water. This plate would act as its own slow-action piston which compresses the fluid with the aid of a powerful electromagnet. The amount of current provided to the electromagnet would be gradually increased until the volume of the water is less than 1/10th of the volume it occupied in its already-pressurized state. The closer the plate moves to the electromagnet, the more strongly it will be attracted even given the same level of energy available.

Although an electromagnetic rail gun is inefficient and requires an extremely long barrel, this mechanism allows for intense electromagnetic energy to be used to compress a fluid which serves as the actuating mechanism, providing all of the benefits of an electromagnetic rail gun without the impractical need for an ultra-long barrel and nuclear electrical plant to produce sufficient power. This system would be portable and can be constructed using existing materials.

Conclusion

Although it is difficult to estimate how great a pressure could be attained using this method, it would certainly be sufficient to propel artillery shells over enormous distances. The only limit would be the strength of the

electromagnet, which would, in turn, be limited only by the strength of the current passed through it.